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CRITERION CONSIDERATIONS FOR MANPOWER MODELS. (U)
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6) CRITERION CONSIDERATIONS FOR MANPOWER MODELS,

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CRITERION CONSIDERATIONS FOR MANPOWER MODELS[1]

In presenting the theme for the 17th Military Operations Research Symposium, the Program Chairman has suggested two questions for our consideration: "How good are model predictions?" and "What are we doing to make them better?" In answering these questions with regard to manpower requirements models, it is important to specify what we mean by the "goodness" of the "model predictions".

For our purposes, a model is simply a logically connected set of rules that abstract selected characteristics of some phenomena or system. This statement is slightly less restrictive but in the same vein as the definition offered by Aris (1964):"... a set of equations ... in which the state of the system is described by some of the variables and the controls or decisions by other variables." We construct a model by stating axioms or rules which correspond to relationships thought to exist in the real system. By manipulating particular variables in the model, we may 1) investigate dependencies among parameters, 2) generate hypotheses concerning significant variables, and 3) evaluate systems.

The systems we wish to evaluate are manpower sub-systems under alternative policies. The variables describing the state of the system are the manpower requirements for specific categories of personnel at various stations, the characteristics of the personnel assets, and the already-determined policies with regard to personnel selection, classification, and rotation. The other variables, which are controlled, represent the policies being evaluated. In evaluating systems, we must have not only the variables which define or describe the system, and those which are controlled--the policies being evaluated--but we must also have the dependent variable, which provides the index or criterion by which the system is being evaluated. It is the value of this index or criterion variable that is the model prediction. The question regarding "goodness" of the model prediction has to do with the degree of isometry between the model criterion index and the criterion variable in the real system under conditions represented by the system descriptions and policy variables.

It is of interest to analyze the significance of a discrepancy between the model criterion index and the criterion variable in the real system. According to one point of view, the model is intended as a simulation of an ideal system. Then, if the model criterion variable

[1] This paper was presented by Dr. Richard C. Sorenson, U. S. Army Personnel Research Office, before the Human Factors Working Group of the Military Operations Research Society at Monterey, California, 24 May, 1966.

is statistically independent of the system criterion index, the real system is at fault and should be modified to bring it closer to the ideal system represented by the model. This would be the case when the variables represented in the model are manpower policies, and the discrepancy between model and real criterion indicates that the system is not operating according to the officially prescribed policy. From the other point of view, the model may be considered a representation or description of the actual or real system, in which case the discrepancy indicates lack of representation and is cause to modify the model and reconstruct the criterion sub-model.

One of the problems we must face in the implementation of a particular manpower model (see Otis, 1966; Sorenson, 1965, 1966; Sorenson and Olson, 1966) is the determination of the appropriate criterion variable. For a given manpower model, there may be several variables that for different applications may be considered criterion indexes. Even for a particular military personnel management application, one or more of the following may be among the criterion variables: reenlistment rate, selection ratio for promotion, amount of reassignment turbulence, quality of fighting force, shortages of particular types of personnel, reduction in attrition of potential leaders. Generally speaking, criterion indexes may be grouped into two categories--restriction criteria and maximization criteria. Restriction criteria are used in identifying infeasible policies, whereas maximization criteria are use to identify an optimal policy or set of policies.

There are alternative strategies open to us when we have multiple criteria. Certainly, policies may be evaluated with regard to a number of restrictive criteria. Those policies for which some of the restrictive criterion variables do not have values exceeding the respective minimum requirements (or have less than maximum permissible values) are considered infeasible policy configurations. Special attention must be given, however, to situations where multiple maximization criterion variables reflect the value of system output. In some situations, the tradeoffs among the criteria may be fruitfully investigated. Disproportionate increases in one criterion value may accompany small decreases in another. Another possibility is that of nesting optimizations. Policies may be determined by specifying a hierachy of optimizations which must be satisfied.

In summary, reconstruction of the criterion sub-model may imply one or more of the following changes in the model: 1) Certain variables must be treated as maximization criteria rather than restrictive criteria. This type of revision is often necessary because in practice the absolute requirements prescribed in personnel management regulations are met as "nearly as possible" rather than absolutely. 2) The criterion must be formed as a different function of the sub-criteria. In effect, in this case, management accepted different tradeoffs among criteria than were represented in the original criterion sub-model. 3) Additional sub-criteria must be considered in forming the ultimate criteria.

In any situation where we have multiple criteria, the criteria have been selected and specified in a particular way because they supposedly relate to some ultimate criterion. Thus, the criterion index in the real system, i.e., the value of the system output, may be considered to be best represented by some function of the multiple optimization criteria. Certainly, it would be advisable to evaluate policies and procedures in terms of total system effectiveness if possible. Thus, in many cases, the fact that we deal with multiple maximization criteria is indicative of the need for further research to relate these sub-criteria to the ultimate system output.

In summary, we see that in order to make our model predictions better--at least in theory--we need to translate the criterion index values into a common metric which has a high degree of isometry with that measure of system effectiveness accepted by management.

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